CHAPTER 5

PESTICIDE HAZARDS AND FIRST AID

LEARNING OBJECTIVES

After studying this chapter, you should:

- Know how to identify and differentiate between types of harmful effects (i.e., acute, delayed, allergic, chronic) associated with pesticide application.
- Understand the hazard level classification system for pesticides, including the associated signal words.
- Know how to identify common exposure routes for various pesticides and application methods.
- Know how to recognize typical symptoms of pesticide exposure in humans and be aware of the appropriate first-aid response.
- Know how to identify other health risks that may occur during pesticide application (e.g., heat stress) and know when to give first aid.

Pesticides are designed to be toxic to living organisms so that control of unwanted pests (plants, insects, rodents, fungi, bacteria, etc.) can be achieved. Though pesticides are also toxic to humans, they vary significantly in the hazards they present. In many respects, living organisms are not all that different from one another, and something that is toxic to one species (animal or plant) may also be toxic to other organisms. This is especially true if the organisms are related. For example, insects, rodents, and humans are all animals and have similarities in their nervous, circulatory, and respiratory systems. These similarities are the reasons that pesticides can affect people.

Pesticides can cause both short-term and long-term effects in humans. Refer to the signal word on the product label and the information contained in the "Hazards to Humans and Domestic Animals" section included in the "Precautionary Statements" section of the label to learn more about human toxicity concerns. Products also can pose physical and chemical risks by being explosive and combustible. If the product presents either a physical or a chemical hazard, this information is included under the "Precautionary Statements." Refer also to the material safety data sheet (MSDS) for more information on toxicity and precautions.

TOXICITY, EXPOSURE, AND HAZARD

Toxicity refers to the ability of a pesticide to cause short-term (**acute**) or long-term (**chronic**) injury. Toxicity is a property of the product itself.

Exposure occurs when pesticides get onto or into the body through the skin, by inhalation, by swallowing, or by eye contact. Product formulations differ greatly in the exposure risk they present. Exposure is often associated with many routine procedures involving pesticides, such as handling opened containers; mixing and loading; working around contaminated application equipment; making spray, mist, or dust applications; cleaning up spills; and reentering a recently treated area before the spray has dried or the dusts have settled.

Hazard, or risk, is the true concern for the applicator or handler. It is the potential or probability for harm (injury, illness, or allergy) to occur because of product toxicity and human exposure. The words "toxicity" and "hazard" are often used interchangeably when describing a pesticide's toxic effect, but they are not the same. "Hazard" reflects both the pesticide's toxicity and the likelihood that you will be exposed to the product in a particular situation. "Toxicity" is a measure of the pesticide's capacity to cause injury, which is a combination of its chemical properties and its concentration. As a result, users of pesticides need to be concerned with the hazards associated with exposure to the chemical and not exclusively with the toxicity of the pesticide. A good equation to remember is:

Hazard (Risk) = Toxicity x Exposure

The following are two examples to illustrate that "hazard" takes into account both toxicity and exposure:

- Gasoline is extremely toxic to humans, especially if swallowed or inhaled. Yet every day, millions of people fill their gas tanks without incident. The toxicity is high, but gas pumps are designed to virtually eliminate human exposure. Therefore, the hazard associated with filling a car's gas tank is very low. If someone siphons gas, the hazard is much greater.
- Aspirin has a low toxicity to humans. However, if children are allowed access to a bottle and ingest many pills, they can become very ill. In this case, aspirin toxicity is low, but the potential for exposure is high, increasing the overall hazard.

Engineering controls such as gas pumps and childproof caps are often designed to reduce exposure. Engineering controls are also available for pesticide mixing and loading that reduce handler exposure (see Chapter 11). These controls include lock-and-load devices and water-soluble bags containing formulated product.

Often the greatest hazard to the applicator occurs during the mixing and loading of the pesticide concentrate. A significant risk of exposure to the chemical in its most concentrated, toxic form exists unless engineering controls are used. Hazards associated with the actual application are frequently much lower because diluted pesticides are being handled or applied. The hazards can still be substantial, however, if a single exposure is high or many exposures occur over an extended period of time.

The best way to avoid or reduce the hazards associated with pesticide use is to understand what you are using and how to use it safely. This means reading the label carefully and following instructions. The attitude of the user is of utmost importance. If applicators mistakenly assume they know exactly how to use a pesticide without reading the product label or do not care to take precautions indicated on the label, accidents are more likely to occur. Pesticide users have legal and moral obligations when using pesticides. In addition to protecting themselves, applicators

must be aware of unprotected people, wildlife, or pets that may be in or near the treatment area which could be exposed to the pesticide during or after the application. Taking adequate precautions and following good safety practices greatly reduces the potential for accidents from pesticide use.

Remember, the pesticide registration process requires that manufacturers perform studies to assess the risk to applicators during the application and the risk to unprotected people after the application. Using the knowledge from these studies, the manufacturer develops product labels that provide details on exposure concerns, personal protective equipment, engineering controls, symptoms of overexposure, first aid, and postapplication restricted-entry intervals (REIs). ***Be sure to read and follow all label directions.***

HARMFUL EFFECTS OF PESTICIDES

Human pesticide injuries occur because products can cause damage by **contact** with skin, eyes, or respiratory tract; can be absorbed by the body and cause **systemic** effects; and can induce **allergic** responses. Any chemical can be harmful; some, even deadly. Many chemicals we are exposed to daily have risks associated with their use because of their toxicity and overexposure. Given pesticides and any other chemical, the risk of illness or injury is determined by both the dose (level of exposure) and the toxicity.

Contact Effects

Contact symptoms include skin irritation (dermatitis), such as itching, redness, rashes, blisters, and burns. Skin discoloration may also occur. Many herbicides and fungicides cause dermatitis. Fumigants can cause severe blisters. If you consider herbicides are the most commonly applied pesticide group, and they predominantly cause contact injury, you can easily understand why ***contact skin effects are the most common form of pesticide injury or poisoning*** to applicators.

Herbicides, fungicides, insecticides, and fumigants may cause eye irritation or injury, sometimes resulting in irreversible damage. Swelling, stinging, and burning of the eyes, nose, mouth, or throat are relatively common contact symptoms. Permanent respiratory damage occurs less often.

Systemic Effects

Systemic effects in humans occur primarily when people are exposed to pesticides that target animals. For example, the nervous system of insects is very similar to that of humans. Thus, an insecticide targeting an insect nervous system often affects a human if the dose is sufficient. Likewise, the blood system in rodents is similar to the human circulatory system. Therefore, rodenticides that target the blood system of rodents may also affect a human. Fumigants are another class of pesticides that can cause systemic injury. The herbicide paraquat causes lethal systemic effects in humans.

Symptoms of systemic injury include:

- Nausea, vomiting, diarrhea, or stomach cramps.
- Headache, dizziness, weakness, or confusion.
- Excessive sweating, tearing, chills, or thirst.
- Chest pains.
- Breathing difficulties.
- Body aches and muscle cramps.

CONTACT EFFECTS

Injury at the point of contact, including skin discoloration and irritation (dermatitis) such as itching, redness, rashes, blisters, and burns. Also, swelling, stinging, and burning of the eyes, nose, mouth, or throat are contact effects.

SYSTEMIC EFFECTS

Poisoning effects that occur at sites other than the entry point into the body.

Allergic Effects

Allergic effects are harmful effects some people develop in reaction to substances that do not cause the same reaction in most other people. If someone develops an allergy to

ALLERGIC EFFECTS /ALLERGY

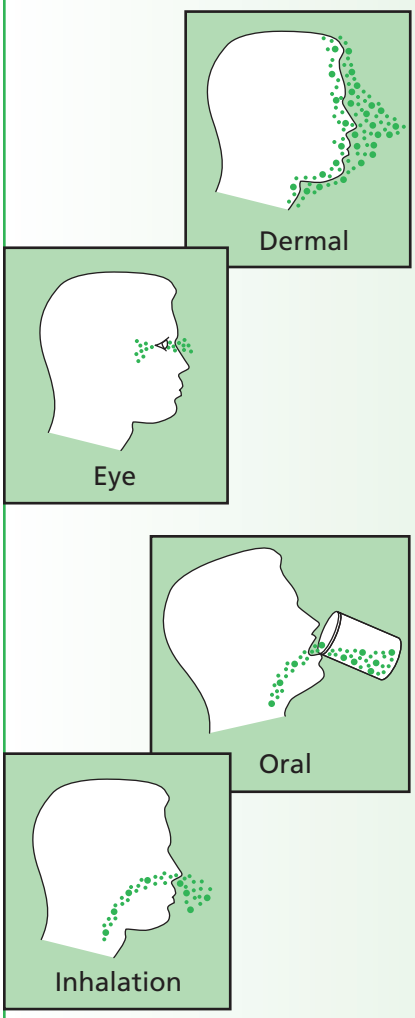
A hypersensitivity to a specific substance, often called the allergen. An allergy may cause dermatitis, blisters, hives, and itching of the eyes. It could also cause illness, asthma-like symptoms or life-threatening shock. Often the entire body is affected.

a chemical contained in a product formulation, the allergy may cause dermatitis, blisters, or hives; it could also cause more serious problems such as asthma or even life-threatening shock. Pesticide allergy symptoms are similar to other allergy symptoms—reddening of the eyes, itchy eyes, respiratory discomfort, and asthma-like symptoms. Unfortunately, there is no way to predict which people will develop allergies to a particular product.

EXPOSURE—HOW PESTICIDES ENTER THE BODY

Pesticide exposure occurs when pesticides get onto or into the body. A pesticide can enter or contact the human body by four primary routes of exposure: the skin (dermal), the eyes, the mouth (oral), and the lungs (inhalation).

Common ways in which pesticide handlers and other workers are exposed to pesticides



Dermal exposure

- **Not wearing gloves or other protective clothing.**
- **Not washing hands after handling pesticides, product containers, or application equipment.**
- **Not washing hands before using the toilet.**
- **Splashing or spilling pesticide on skin.**
- **Being exposed to spray or dust drift.**
- **Applying pesticides in windy weather or above your head.**
- **Touching treated plants, soil, or livestock.**

Eye exposure

- **Rubbing eyes with contaminated gloves or hands.**
- **Splashing pesticide in eyes.**
- **Handling dry formulations when not wearing eye protection.**
- **Applying pesticides in windy weather.**

Oral exposure

- **Not washing hands before eating, smoking, chewing, or drinking.**
- **Splashing pesticide in mouth.**

Inhalation exposure

- **Handling pesticides in confined or poorly ventilated areas.**
- **Handling dusts or powders.**
- **Using an inadequate or poorly fitting respirator.**
- **Being exposed to spray or dust drift.**

Skin or Dermal Route

In most exposure situations, the skin is the primary route of pesticide entry onto or into the body. Evidence indicates that about 97 percent of all body exposure to pesticides during a spraying operation is by skin contact. Dermal absorption or contact injury may occur as the result of airborne dust, splashes, spills, or spray mist when mixing, loading, applying, or disposing of pesticides. Skin exposure may also result from contact with pesticide residues on treated surfaces or contaminated equipment during cleaning or repair.

If absorption and the resulting systemic injury are the primary concerns with a particular product, the specific hazard depends on the extent of the exposure, the site of contamination on the body, the way the pesticide is formulated, and the absorption rate into the body. Some products that cause systemic injury are just as toxic when absorbed through the skin as when they are swallowed.

Parts of the body differ in their ability to absorb pesticides. Warm, moist areas such as the groin, armpits, head, neck, backs of hands, and tops of the feet tend to absorb more than the palms and forearms (Figure 5.1). However, the palms and forearms must still be protected because they get the most exposure. Cuts, abrasions, and skin rashes can increase absorption.

Pesticide formulations vary in their ability to penetrate skin. In general, water-soluble liquids or powders, wettable powders, dusts, and granular pesticides do not penetrate skin very easily. However, oil-based liquid formulations such as emulsifiable concentrates are readily absorbed, and wettable powder and emulsifiable concentrate products have a higher concentration of active ingredient than dusts and granules.

Application techniques can also affect exposure levels for applicators. Making overhead applications, using blower application equipment for mists and dusts, using animal pour-ons or dipping livestock and pets are all application methods that tend to have high dermal exposure levels. Contaminated hands or gloves can transfer pesticides to other body parts. Again, a reminder on personal hygiene—be sure to wash your hands and gloves after each pesticide handling event.

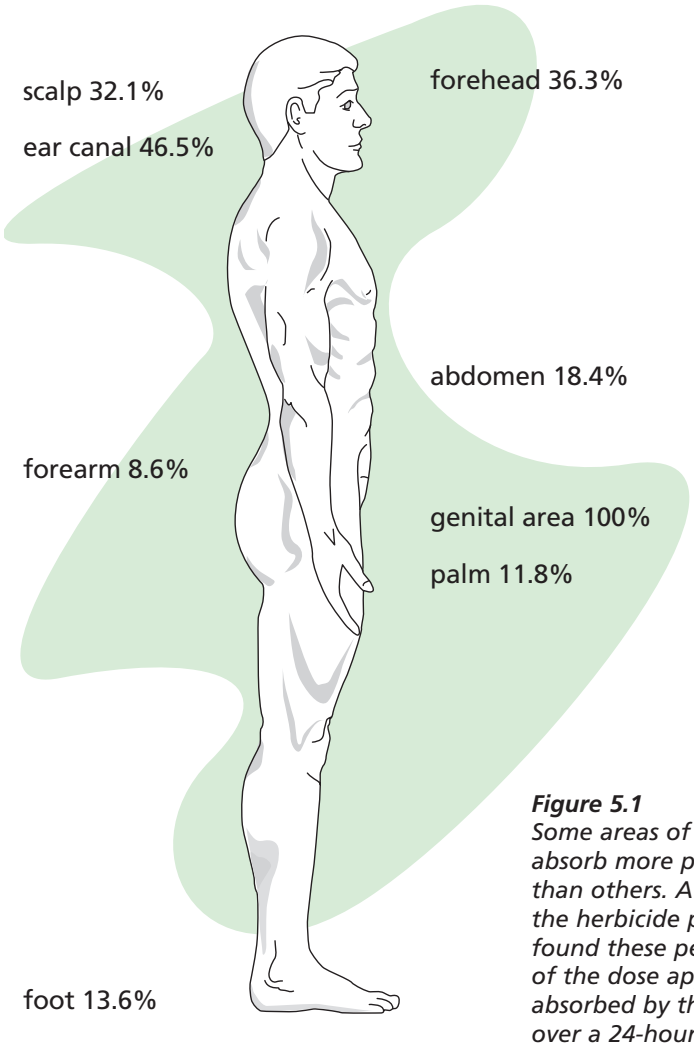


Figure 5.1
Some areas of the skin absorb more pesticide than others. A study of the herbicide parathion found these percentages of the dose applied were absorbed by the skin over a 24-hour period (Maibach and Feldman, 1974).

Eyes

The tissues of the eye are extremely absorbent. Blood vessels are very close to the surface of the eye, so pesticides can be easily absorbed into the bloodstream. Under certain conditions and using certain pesticides, absorption through the eyes can be significant and particularly hazardous. Eyes are very sensitive to many pesticides and, for their size, are able to absorb surprisingly large amounts of chemical. In addition to systemic concerns, some products are corrosive and can cause severe eye damage or even blindness. Serious eye exposure can result from airborne dusts or particles,

splashes or spills, broken hoses, spray mists, or from rubbing the eyes with contaminated hands or clothing.

Inhalation Route

Protecting the lungs is important when mixing, loading, or applying pesticides especially in confined areas. If inhaled in sufficient amounts, pesticides can cause contact damage to nose, throat, and lung tissue. Once breathed into the lungs, pesticides can enter the bloodstream very rapidly and completely, eventually resulting in damage to other body organs (systemic illness). Another major concern is the aspiration of petroleum solvents (emulsifiable concentrate formulations) and other materials into the lungs when someone has induced vomiting after a particular product has been swallowed. As the person vomits, some of the material is suctioned (aspirated) into the lungs, where it can cause severe damage.

Oral Route

Accidental oral exposure occurs most frequently when children have access to rodent baits or other improperly stored pesticides in the home or when pesticides have been taken from the original, labeled container and put into an unlabeled bottle or food container. Unfortunately, children are the most common victims of these mishaps.

When people work around pesticides, oral exposure can occur when liquid concentrates splash into the mouth during mixing and loading of pesticides or cleaning of equipment. Never use your mouth to clear a spray line or to begin siphoning a pesticide. Chemicals can also be swallowed when eating, drinking, or smoking, or even licking one's lips, especially if contaminated hands transfer product to the mouth. Because many pesticides are rapidly and completely absorbed by the intestinal tract, wash your hands and face thoroughly before eating, drinking, or smoking. Mark all pesticide measuring cups and containers to ensure that no one uses them for water, drink, or food. Never store pesticides in beverage or other food containers. Practice good personal hygiene and wear the proper protective equipment to avoid exposure. Preventing exposure is a key principle in the safe use of pesticides.

PRODUCT TOXICITY AND HEALTH CONCERNS

ACUTE TOXICITY

Injury or illness produced from a single exposure. LD_{50} and LC_{50} are common measures of the degree of acute toxicity.

CHRONIC TOXICITY

The ability of small amounts of pesticide from repeated, prolonged exposure to cause injury or illness.

Toxicity of a particular pesticide is estimated by subjecting test animals (usually rats, mice, rabbits, and dogs) to various dosages of the active ingredient and to each of its formulated products. Toxicity, measured for both short-term (**acute**) exposure and long-term (**chronic**) exposure, is evaluated at a range of doses that cause no immediate effects, at doses where there are some immediate effects, at doses where there are delayed or long-term effects, and at the dose where death occurs.

Acute Toxicity

Acute toxicity is the measure of harm (systemic or contact) caused by a single, one-time exposure event. Acute effects are determined after test animals have been exposed through contact with their skin and eyes, and through ingestion and inhalation. The harmful effects may be systemic or contact in nature (or a combination of both), depending on the product, formulation, dose, and route of exposure. Acute effects occur shortly after exposure, usually within 24 hours.

The following example of acute toxicity illustrates the harmful effects that can occur when people are exposed to a harmful dose of alcohol:

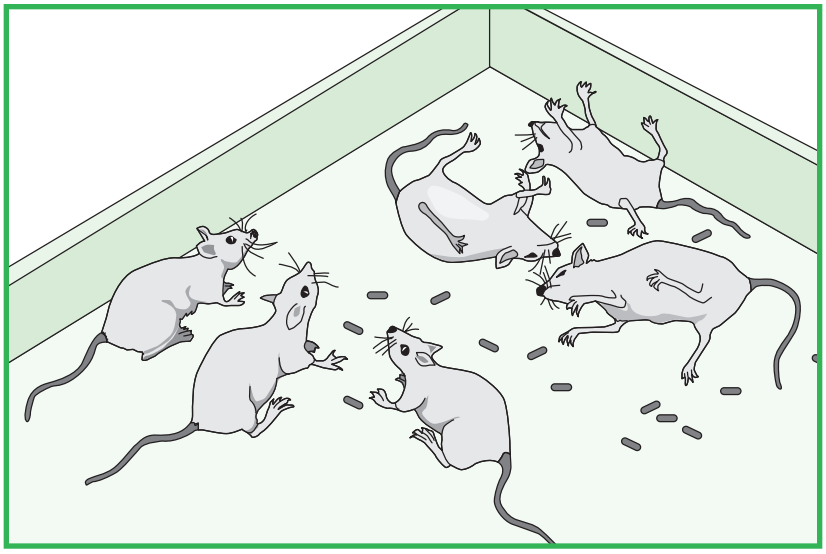
> *Alcohol consumption is fairly common. Annually, only a few people die from lethal alcohol toxicity due to a single exposure event. Many people, however, have varying levels of harmful effects due to overexposure, such as headaches, digestive disorders, and disorientation. People's symptoms from drinking alcohol depend on the dose, the exposure period, and their own body chemistry and weight.*

Acute systemic toxicity is the measure of illness or death resulting from a change in critical body function in the animal. The common method used for comparing acute toxicity is the **LD_{50}**, or lethal dose 50 percent. The LD_{50} is the dose of a toxicant required to kill 50 percent of the population of test animals under a standard set of conditions. For comparison purposes, LD_{50} values of pesticides are recorded in milligrams of toxicant per kilogram of body weight of the test animal (mg/kg). When the test animal is exposed to the material by feeding, the result is referred to as the **oral LD_{50}**. When the material is tested by skin exposure, the result is referred to as the **dermal LD_{50}**. A few products are toxic at low doses by either dermal or oral exposure, such as the insecticides parathion and methamidophos.

Another commonly used measure of acute toxicity is the **LC_{50}** or lethal concentration 50 percent. This is the concentration of a substance in air or water required to kill 50 percent of the test population. The LC_{50} is generally expressed as a ratio of the proportional amount of pesticide to a total volume of air or water. This is commonly expressed in parts per million (ppm) or milligrams per liter (mg/l). The LC_{50} is a common measure of lethal effects of chemicals on fish and other aquatic organisms. The LC_{50} values most directly applicable to human health are those expressing lethal concentration of chemicals in air.

The LD_{50} and LC_{50} values are useful in comparing the systemic toxicity of different active ingredients as well as different formulations of the same active ingredient. The lower the LD_{50} value of a pesticide, the less it takes to kill 50 percent of the population of test animals. Therefore, the greater the toxicity of the chemical. Pesticides with an LD_{50} value of less than 50mg/kg by oral exposure or 200 mg/kg by dermal exposure, or an LC_{50} value of less than 0.2 mg/l by inhalation exposure are legally classified as **poisons**. Poisons are those products that have the potential to kill humans at very low exposures (less than a teaspoon). Any product with this toxicity concern has the **signal words** DANGER—POISON in red letters and the skull and crossbones symbol on the label. Products with the POISON classification include most fumigants, some rodenticides, several insecticides, and a few herbicides.

The LD_{50} and LC_{50} have limitations because they measure only one toxic effect—death. They do not give any indication of what dose may lead to other less serious, acute systemic effects or to other, possibly equally serious contact effects or delayed systemic effects. Also, they do not translate directly to humans because our body systems are slightly different from those of test animals (e.g., rats, mice, etc.). Lastly, the LD_{50} and LC_{50} are measures of a single exposure, not the potential buildup of effects resulting from multiple exposures.



Adapted from University of Illinois *General Standards* manual

LD_{50} is the amount of pesticide that kills half of the test animals.

Some pesticides produce acute toxic effects because of their corrosive or irritant properties. These can result in respiratory, skin, or eye irritation or damage. Some can cause severe burns or permanent blindness. Chemicals with these irritant or corrosive properties need to be used with extra care. Fungicides, herbicides, and some insecticides pose contact injury concerns. Manufacturers list non-lethal systemic and contact effects in addition to the signal word. Systemic and contact acute toxicity concerns are indicated by the signal words and further explained in the "Precautionary Statements" portion

The lower the LD_{50} value of a pesticide, the less it takes to kill 50 percent of the population of test animals. Therefore, the greater the toxicity of the chemical.

of the product label under the "Hazards to Humans and Domestic Animals" section.

DANGER/POISON
PELIGRO

Fatal if swallowed. May cause blindness if swallowed. May be fatal if inhaled or absorbed through eyes. Causes irreversible eye damage. Do not get in eyes, on skin, or on clothing. Do not breath vapors or spray mist.

Hazard Class 1 pesticides that are highly toxic due to acute oral, dermal, and inhalation toxicity must have the signal words DANGER and POISON and the Spanish word for danger, PELIGRO, in red letters, and the skull and crossbones symbol prominently displayed on the package label.

The EPA and the manufacturer take into account both systemic and contact toxicity measures in assigning the product's signal word and toxicity category. These are assigned on the basis of the greatest concern, be it oral, dermal, or inhalation systemic effects, or skin, eyes, or respiratory tract contact effects.

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Hazard Class 1 pesticides that are highly toxic due to acute contact toxicity must have the word DANGER but not the word POISON or the skull and crossbones symbol.

Signal words and skull and crossbones symbol

There are four distinct signal words found on pesticide labels: DANGER—POISON, DANGER, WARNING, and CAUTION. Signal words are also found on other chemical products used around work and home, such as paint, oven cleaner, dish soap, antifreeze, and window cleaner, to name a few. Signal words are based on the toxicity of the product. Depending on their toxicity, they are categorized into several classes of hazard. Some very low toxicity products (Hazard Class IV) are not required to have a signal word.

Danger—Poison

Pesticides classified as highly toxic (Hazard Class I) with acute oral LD_{50} values from a trace to 50 mg/kg must have the signal words DANGER and POISON (in red letters) and a skull and crossbones symbol prominently displayed on the package label. The lethal toxicity may be based on oral, dermal, or inhalation exposure.

PELIGRO, the Spanish word for DANGER, must also appear on the labels of highly toxic chemicals. As little as a few drops of a DANGER—POISON material taken orally could be fatal to a 150-pound person. Note that the human oral LD_{50} of paraquat, a herbicide active ingredient, is 3 to 5 mg/kg, whereas the rat oral LD_{50} is 150 mg/kg. Consult the precautionary statements that follow the signal word and symbol on the label to learn more about the product's hazard to humans. Most fumigants, some insecticides and rodenticides, and a few herbicides are assigned the DANGER—POISON signal word.

Danger

Some highly toxic (Hazard Class I) pesticide products carry the signal word DANGER (without the word "poison" or the skull and crossbones symbol) because of their potential to cause acute contact injury. DANGER indicates the potential for permanent or severe damage to skin, eyes, or lungs. These contact effects are more dangerous than the acute systemic toxicity (LD_{50}) of the product. Several carry warnings of concern about their causing irreversible eye damage at low exposures. Consult the precautionary statements that follow the signal word on the label to learn more about the product's hazard for humans. Some herbicides, insecticides, and antimicrobials carry the DANGER signal word.

Table 5.1 Toxicity Categories

Signal Word & Symbol	Toxicity Level & Class	Oral LD_{50} (mg/kg)	LD_{50} Dermal (mg/kg)	LC_{50} Inhalation (mg/l)	Contact Injury Concern	Toxicity Concern
DANGER—POISON/PELIGRO Skull & Crossbones	Highly toxic, Hazard Class I	Trace to 50	Trace to 200	Trace to 0.2	Signal word based on oral, dermal, or inhalation toxicity.	Very low dose could kill a person (a few drops to 1 teaspoon).
DANGER/PELIGRO	Highly toxic, Hazard Class I				Corrosive—permanent or severe skin, eye, or respiratory damage.	Based on the corrosive or irritant properties of the product.
WARNING/AVISO	Moderately toxic, Hazard Class II	50 to 500	200 to 2,000	0.2 to 2	Moderate skin, eye, or respiratory damage.	Small to medium dose could cause death, illness, or skin, eye, or respiratory damage (1 teaspoon to 1 ounce).
CAUTION	Slightly toxic, Hazard Class III	500 to 5,000	2,000 to 20,000	2 to 20	Mild skin, eye, or respiratory irritation.	Medium to large dose could cause death, illness, or skin, eye, or respiratory damage (1 ounce to 1 pint or 1 pound).
CAUTION or no signal word	Hazard Class IV	Greater than 5,000	Greater than 20,000	Greater than 20	Slight concern for skin, eye, or respiratory injury.	Slight to none (over 1 pint or 1 pound).

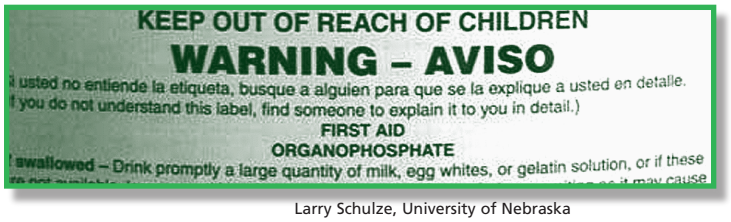
Warning

A pesticide product considered moderately toxic (Hazard Class II) must have the signal words WARNING and AVISO (Spanish) on its label. If the concern is due to systemic toxicity, the acute oral LD_{50} values range from 50 to 500 mg/kg; 1 teaspoonful to 1 ounce (2 tablespoons) of this material could be fatal to a 150-pound person. The concern could also be due to contact injury to skin, eyes, or respiratory tract. The WARNING signal word alone does not indicate whether the concern is systemic or contact or both. Consult the precautionary statements that follow the signal word on the label to learn about the product's specific contact or systemic hazard for humans.

Caution

Pesticide products classified as slightly toxic (Hazard Class III) are required to have the signal word CAUTION on the pesticide label. Acute toxicity may be systemic or contact in nature. If systemic, the acute oral LD_{50} values are between 500 mg/kg and 5,000 mg/kg. Contact effects are generally irritation of eyes, skin, or respiratory tract. Consult the precautionary statements that follow the signal word on the label to learn about the product's contact or systemic hazard to humans.

Hazard Class II pesticides must have the signal word WARNING (AVISO in Spanish) on its label.



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Hazard Class III pesticides are required to have the signal word CAUTION on the label.

Chronic Toxicity

The **chronic toxicity** of a pesticide is determined by subjecting test animals to long-term exposure to an

active ingredient, typically two years. The harmful effects that occur from small, repeated doses over time are termed chronic effects.

A non-pesticidal example of chronic toxicity is the relationship between tobacco and lung cancer. Not everyone who smokes gets lung cancer. However, a significant number of people who smoke for years do get lung cancer. Another example of chronic toxicity is liver damage resulting from long-term exposure to moderate or high levels of alcohol.

The suspected chronic effects from exposure to certain pesticides include genetic changes, non-cancerous or cancerous tumors, reproductive effects, infertility, fetal toxicity, miscarriages, birth defects, blood disorders, and nerve disorders.

If a product causes chronic effects in laboratory animals, the manufacturer is required to include chronic toxicity warning statements on the product label. This information is also listed on the MSDS. The chronic toxicity of a pesticide is more difficult to determine through laboratory analysis than the acute toxicity.

Delayed Effects

Delayed effects are illnesses or injuries that do not appear immediately (within 24 hours) after exposure to a pesticide. They may be delayed for weeks, months or even years. Whether or not you experience delayed effects depends on the pesticide, the extent and route of exposure(s), and how often you were exposed. Under "Precautionary Statements," the label states any delayed effects that the pesticide might cause and how to avoid exposures leading to them. Wearing extra protective gear and taking additional precautions may be necessary to reduce the risk of delayed effects. Delayed effects may be caused by either an acute exposure or chronic exposure to a pesticide.

SYMPTOM RECOGNITION

Symptoms can be correlated with certain groups of pesticides. For example, borates (insecticides) tend to be irritating to the skin, nose, and respiratory system, while some fungicides are irritants to the skin, eyes, and mucous membranes of the respiratory system. Anticoagulant-type rodenticides may cause bloody noses and bleeding gums. Organophosphate and carbamate insecticides may cause all of the systemic symptoms listed *(see sidebar on the next page)* that could ultimately result in respiratory failure and death. Symptoms associated with synthetic pyrethroid insecticides include nausea, dizziness, weakness, nervousness, eye, and skin irritation. 2,4-D and some other related herbicides (dicamba, MCPA, and MCPP) are irritating to the skin and mucous membranes, and they can also cause vomiting, headaches, diarrhea, and confusion.

Reference material for toxicological symptoms.

Because symptoms of pesticide poisoning or exposure can vary widely, physicians need training to recognize this variability and treat appropriately. A manual entitled *Recognition and Management of Pesticide Poisonings* provides treatment guidelines for physicians to follow in the case of pesticide poisonings. This manual can be obtained through the EPA Office of Pesticide Programs or from the EPA Web site http://www.epa.gov/.

Cholinesterase Inhibition

Cholinesterase inhibition due to exposure to organophosphate or carbamate insecticides can cause acute or delayed effects. Each person has a certain baseline level of cholinesterase enzyme that is considered normal for that individual. Organophosphate or carbamate exposure inhibits cholinesterase, resulting in continual overexcitation of nerve-to-nerve and nerve-to-muscle communication. Large exposures to these insecticides can cause immediate illness. Smaller exposures may not outwardly cause symptoms, but small, repeated exposures over several days or weeks may continually reduce the body's cholinesterase level and ultimately trigger mild, moderate, or severe symptoms of overexposure.

In the case of cholinesterase inhibition, it is not always obvious whether a worker is showing symptoms from an acute exposure or experiencing delayed effects from repeated exposures. For example, an applicator who is exposed to a single, large amount of an organophosphate may suffer acute effects. However, if over time the applicator is exposed to several small amounts, cholinesterase levels are reduced slightly at each exposure. Eventually, a small additional exposure can cause illness. In this example, the illness sets in soon after an exposure, but only if there were previous repeated exposures.

Cholinesterase Monitoring

The blood cholinesterase test measures the effect of exposure to organophosphate and carbamate insecticides. Cholinesterase levels can vary considerably between individuals so a baseline must be established for each person. A small percentage of the population has a genetically determined low level of cholinesterase. Even minimal exposure to cholinesterase inhibitors can present a substantial risk to these people. Always conduct baseline testing during the time of year when insecticides are not being used or at least 30 days from the most recent exposure. Establishing an accurate baseline value often requires that two tests be performed at least 72 hours but not more than 14 days apart.

If you are using organophosphate or carbamate insecticides, cholinesterase tests can be periodically taken and results compared with your previously established baseline level. Also, anytime you feel ill or have mild or moderate symptoms of poisoning, your physician should conduct a blood test to evaluate your cholinesterase level and compare it with the baseline level. The purpose of routine or emergency cholinesterase monitoring is to enable a physician to recognize the occurrence of excessive exposure to organophosphate and carbamate insecticides. A significant reduction in your body's cholinesterase level indicates poisoning. A physician normally suggests that thepesticidehandler be removed from further exposure. A reduction in cholinesterase may require that you have no exposure for a certain period to allow your body time to build new cholinesterase. Your physician can help to establish the frequency of this testing program. Physicians who specialize in occupational and environmental medicine are most familiar with this type of testing program.

Common symptoms associated with organophospate and carbamate insecticide poisoning

Mild poisoning

- Fatigue
- Headache
- Dizziness
- Blurred vision
- Excessive sweating/salivation
- Nausea and vomiting
- Stomach cramps and diarrhea

Moderate poisoning

- Inability to walk
- Weakness
- Chest discomfort
- Constriction of pupils
- Mild symptoms more severe

Severe poisoning

- Unconsciousness
- Severe constriction of pupils
- Muscle twitching
- Running nose and drooling
- Breathing difficulty
- Coma and death

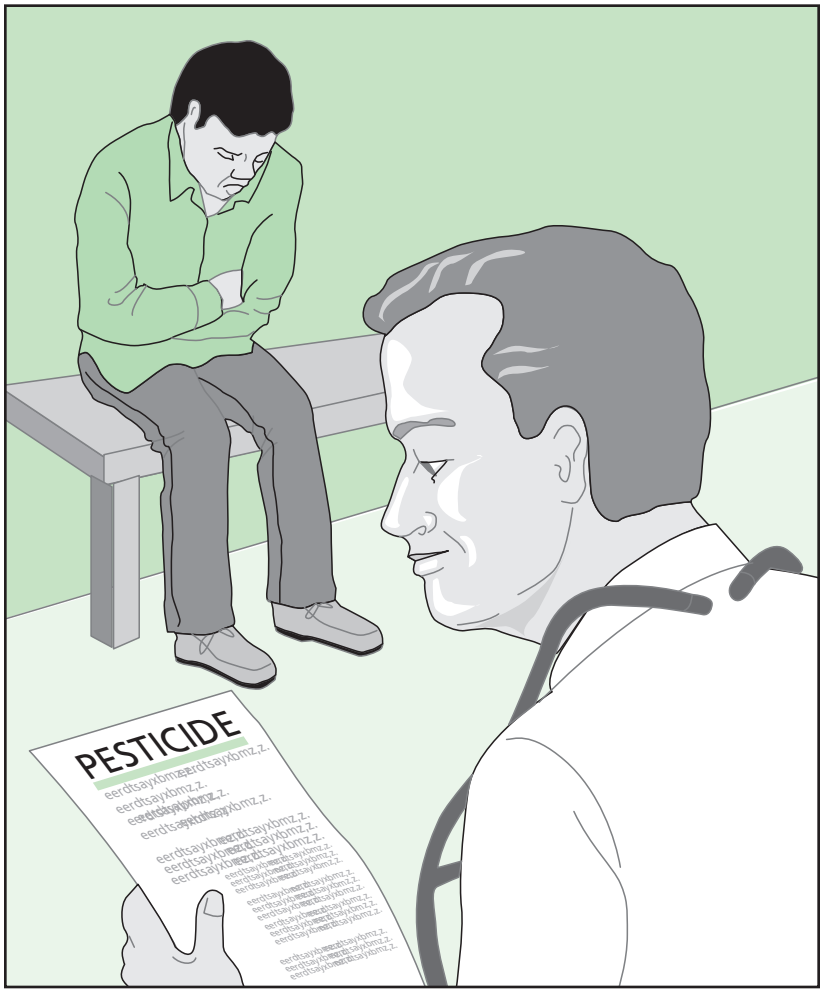
FIRST AID FOR PESTICIDE POISONING

National Poison Control Center 1-800-222-1222 (Staffed 24 hours)

Animal Poison Control Center (APCC) 1-888-426-4435

National Pesticide Information Center (NPIC) 1-800-858-7378

Get medical advice immediately if you or any of your fellow workers have unusual or unexplained symptoms that develop within 24 hours of a pesticide exposure. Be alert for the early symptoms of pesticide poisoning and contact effects in yourself and others. Recognizing symptoms early and providing an immediate first-aid response may save a life or prevent permanent injury. Do not wait until you or someone else gets dangerously ill before calling a physician or going to a hospital. It is better to be too cautious than to act too late. Take the pesticide label with you, either a duplicate copy or the one attached to the container (or at a minimum, the EPA registration number of the product). To avoid contamination and exposure, do not carry pesticides in the passenger space of the vehicle.



Always bring the label with you when seeking medical advice for exposure symptoms.

The doctor needs to know the pesticide ingredients to determine the proper course of treatment. It is a good idea to print off extra copies of the label from the Internet and place one copy in your service vehicle and one in your office for use during medical emergencies.

Remember, certain symptoms are not always the result of pesticide exposure. Common illnesses such as the flu, heat exhaustion or heat stroke, pneumonia, asthma, respiratory or intestinal infections, and even a hangover can cause similar symptoms. Contact with certain plants such as poison oak or poison ivy can also produce skin effects like those resulting from pesticide exposure. However, when symptoms appear after contact with pesticides, always seek medical attention immediately.

General First-aid

First aid is the initial effort to help a victim while medical help is on the way. If you are alone with the victim, make sure he/she is breathing and is not being further exposed to the pesticide before you call for emergency assistance. Protect yourself from pesticide exposure prior to and while giving assistance. Make sure you wear the appropriate personal protective equipment (PPE), including a respirator, before assisting someone in an enclosed area. Apply artificial respiration if the victim is not breathing and is not vomiting.

Immediate action can indeed be a life-or-death matter in a pesticide poisoning. The product label is the primary source of information. Follow the label's specific first-aid instructions carefully. In addition, call the **National Poison Control Center (1-800-222-1222)** or a physician. First aid is only the first response and is not a substitute for professional medical help. It is very important to get the victim to a hospital without delay. The following are a few key points to remember when administering first aid during a pesticide emergency:

- If oral or dermal exposure has occurred, the first objective is usually to dilute the pesticide and prevent absorption.
- Always have a source of clean water available. In an extreme emergency, even water from a farm pond, irrigation system, or watering trough could be used to dilute the pesticide.
- Never try to give anything by mouth to an unconscious person.
- If inhalation exposure occurs, get the victim to fresh air immediately.
- Become familiar with the proper techniques of artificial respiration; it may be necessary if a person's breathing has stopped or becomes impaired.
- If there is a likelihood of first responders being directly exposed to a pesticide, be sure they wear appropriate PPE.

In addition to the National Poison Control Center (it is staffed 24 hours each day); you can call the National Pesticide Information Center (NPIC). Located in Corvallis, Oregon, it provides a variety of information about pesticides to anyone in the United States seven days per week from 6:30 a.m. to 4:30 p.m. Pacific time (1-800-858-7378; http://npic.orst.edu). Post all emergency numbers by the telephone and in service vehicles involved in handling pesticides.

Pets, horses, and other livestock can also be poisoned by exposure to pesticides. Emergency information on the treatment of pets or livestock harmed by pesticide contamination or poisoning can be obtained by contacting the Animal Poison Control Center (APCC) at 1-888-426-4435.

Pesticide on the Skin

Proper hygiene helps to protect the skin from pesticide exposure. Always have an adequate water supply with you anytime that skin exposure is possible.

- Remove all contaminated clothing immediately.
- Wash the affected area, including the hair, with water and soap, then rinse well. Use of a shower is best. Avoid harsh scrubbing, which enhances pesticide absorption.
- Gently dry the affected area and wrap it in loose cloth or a blanket, if necessary.
- If the skin has chemical burns, cover the area loosely with a clean, soft cloth. Avoid using ointments, greases, powders, and other medications unless instructed to do so by a medical authority.

Washing your hands with water and soap after using pesticides prevents skin contamination.

It is often best to dispose of contaminated clothing, especially if there is any concern about getting the contaminated clothing clean. Place it in a plastic bag, seal the bag and write on the bag the name of the material that contaminated it. Take it to a household hazardous waste collection. If you decide to keep the clothing, store and wash it separately from the family laundry.

Pesticide in the Eye

Because the eyes readily absorb material that gets into them, fast action is required.

- Hold the eyelid open and immediately begin gently washing the eye with drips of clean water. Do not use chemicals or drugs in the wash water unless instructed to do so by a physician or a poison control center.
- Drip the water across the eye, not directly into the eye, or use an eyewash dispenser.
- Continuously rinse the eye for 15 minutes. If only one eye is involved, be careful not to contaminate the other eye.

- Flush under the eyelids with water to remove debris.
- Cover the eye with a clean piece of cloth and seek medical attention immediately.

Inhaled Pesticide

The basic first-aid procedure for someone who has inhaled a pesticide is to get the exposed person to fresh air.

- Immediately carry the victim to fresh air (do not allow the victim to walk).
- Do not attempt to rescue someone who is in an enclosed, contaminated area unless you are wearing appropriate PPE.
- If other people are in the area, warn them of the danger.
- Have the victim lie down and loosen clothing.
- Keep the victim warm and quiet. Do not allow him/her to become chilled or overheated.
- If the victim is convulsing, protect the victim's head and watch that breathing continues.
- Keep the person's chin up to ensure that air passages are open for breathing.
- If breathing stops or is irregular, give artificial respiration.

Pesticide in the Mouth or Swallowed

If pesticide has gotten in the mouth but has not been swallowed, rinse the mouth with plenty of water. After the mouth has been thoroughly rinsed, give the victim large amounts (up to 1 quart) of milk or water to drink. If the pesticide is swallowed, one of the most critical first-aid decisions is whether to induce vomiting. Induce vomiting **only** if the label instructs to do so. Several pesticides cause more harm when vomited than if they remain in the stomach. To provide first aid for a swallowed pesticide, you must know the appropriate treatment. The decision to induce vomiting must be made quickly and accurately—the victim's life may depend on it.

Never induce vomiting if the victim:

- Is unconscious or having convulsions.
- Has swallowed a corrosive poison, such as a strong alkali or acid. The material burns the throat and mouth as severely coming up as it did going down. Also, it can be aspirated into the lungs and cause more damage.
- Has swallowed an emulsifiable concentrate or oil solution product, which is dissolved in petroleum solvents. Emulsifiable concentrates and oil solutions may cause death if aspirated into the lungs during vomiting.

How to Induce Vomiting

Induce vomiting only as a first-aid measure until you can get the victim to a hospital. Do not waste a lot of time attempting to induce vomiting.

- Make sure the victim is kneeling forward or lying on his side to prevent vomit from entering the lungs and causing additional damage.
- First give the victim at least 2 glasses of water to dilute the product. Do not use carbonated beverages.
- To induce vomiting, put your finger or the blunt end of a spoon at the back of the throat. Do not use anything sharp or pointed. Do not use salt water to induce vomiting.
- Collect some of the vomitus for the doctor, who may need it for chemical analysis.

Activated charcoal is another first-aid treatment that can be administered when a pesticide has been swallowed. Give the patient 2 to 4 tablespoons of activated charcoal in at least 8 ounces of water. Activated charcoal acts as a magnet to adsorb many chemicals. Pharmaceutical grade activated charcoal is available from most drug

stores. Activated charcoal prepared for cleaning up pesticide spills may be substituted in an emergency. Take the victim to a physician or hospital.

Only general first-aid practices have been discussed here. Contact the Poison Control Center for further assistance in administering first-aid. If necessary, get the victim to a doctor or hospital, and take the pesticide label with you.

Antidotes

Antidotes are available for only a few classes of pesticides—anticoagulant-type rodenticides and the organophosphate or carbamate insecticides. Antidotes can be extremely dangerous if misused, so they should be prescribed and administered only by a qualified physician. Antidotes should never be used to prevent poisoning.

Atropine sulfate. This antidote is given for carbamate insecticide poisoning. The need and dosage are based on the body weight of the victim. It is always given alone for carbamate poisoning. It can be given repeatedly as symptoms reoccur.

Atropine sulfate in combination with 2-PAM (protopam chloride). This antidote combination is given for organophosphate insecticide poisoning. The combination actually helps to reactivate cholinesterase in organophosphate poisoning cases; reactivation does not occur with atropine treatment for carbamate poisonings.

Vitamin K_1. This antidote is used for treating exposures to anticoagulant rodenticides. Anticoagulant rodenticides cause internal bleeding and prevent blood clotting. Vitamin K_1 helps restore the ability of the blood to clot normally.

Note: Ipecac syrup, used as an emetic for almost 50 years, is **no longer recommended for routine use in most poisonings.** Clinical studies have demonstrated no benefit from its use. Ipecac works too slowly (about 20 minutes) in inducing vomiting and results in only about one-third of stomach contents being voided.

HEAT STRESS

Heat stress occurs when the body is subjected to a level of heat with which it cannot cope. Heat stress can affect both pesticide handlers and workers. With heat stress, the heat, not pesticide exposure, causes certain symptoms. PPE worn during handling or early-entry activities can increase the risk of heat stress. The protective qualities of the PPE may restrict the evaporation of sweat, thus impeding the body's natural cooling system. If you are under a physician's care, consult your physician before working in hot or humid conditions. Special PPE is available to assist in maintaining a cool body temperature.

Symptoms of Heat Stress

Mild forms of heat stress make people feel ill and impair their ability to do a good job. You may feel weak and get tired sooner than usual. In addition, you may be less alert and less able to use good judgment. Severe heat stress, also known as heat stroke, is life-threatening. The normal body temperature is 97.7 degrees F. With heat stroke, body temperature may exceed 105 degrees F. Staggering, unconsciousness, or convulsions may result. Lack of sweating is a common symptom of heat stroke. Brain damage or even death can occur if the heat stroke victim is not cooled down quickly. More than 10 percent of severe heat stress victims die, including young, healthy adults. Sometimes victims remain highly sensitive to heat for months and are unable to return to the same work.

Heat stress symptoms include:

- Fatigue (exhaustion, muscle weakness).
- Dizziness and fainting.
- Clammy skin or hot, dry skin.

Avoid heat stress by taking breaks and drinking water throughout the workday.

- Altered behavior—confusion, slurred speech, quarrelsome, irrational.
- Headache, nausea, and chills.
- Severe thirst and dry mouth.
- Heavy sweating or complete lack of sweating.

Learn more about symptoms of heat stress and take immediate action to cool down if you suspect you may be suffering from even mild heat stress. Drink plenty of water and take breaks in the shade throughout the workday.

SUMMARY

Pesticide risk can be summarized by the formula **hazard=toxicity x exposure**, where "toxicity" is the capacity of the pesticide to cause short-term (acute) or long-term (chronic) injury or illness and "exposure" is the means by which the pesticide gets into or onto the body. These two factors determine the likelihood that harm (i.e., hazard) will occur to the individual who handles pesticides. Pesticide users can reduce the chances of acute or chronic injury by taking measures to prevent exposure.

Harmful effects of pesticides may occur by direct contact, by uptake into the body (i.e., systemic effects and by allergic reactions). These risks can be reduced by understanding pesticide exposure routes, ways by which pesticides can enter or contact the body: by the skin (dermal), eyes, mouth (oral), and the lungs (inhalation). Pesticide handlers can prevent exposure by following label directions, using the proper application techniques, and wearing appropriate PPE.

Another way to reduce risk is to use the least toxic pesticide that will do the job, thereby reducing the risk of acute injury. In some cases, it may be better to choose a more toxic pesticide that can be used less frequently, thus reducing the risk of chronic injury or illness. The toxicity of a pesticide product is measured by the LD_{50} and the LC_{50} values. These values determine the type of signal word that occurs on a pesticide label. Signal words—DANGER—POISON, DANGER, WARNING, and CAUTION—help the user recognize how toxic the pesticide is and what precautions to take.

Pesticide handlers need to be aware of the symptoms of pesticide poisoning to know when to seek medical attention. Not all symptoms occur immediately following a pesticide exposure. Some symptoms are the result of chronic exposure (i.e., small, repeated doses over time). People who use pesticides routinely should have regular medical checkups to determine if they are experiencing any ill effects from pesticide use. For example, measuring blood cholinesterase is one way to determine if certain insecticides are affecting an individual before symptoms appear. People affected by chronic toxicity must remove themselves from the exposure situation.

Early recognition of symptoms of pesticide poisoning is the key to preventing the potential for further injury. Victims of single, acute toxic exposures must be assisted and taken to a doctor or hospital immediately following any necessary first-aid procedures. The first-aid methods used depends on how the exposure occurred—to the skin, eyes, or mouth, or by inhalation. The label often has important information on first-aid procedures for the particular pesticide product. Make sure a copy of the label is readily available whenever you are using pesticides, and take the label to the physician if a poisoning incident occurs.